UNIVERSITY OF MACEDONIA
SCHOOL OF INFORMATION SCIENCES
CMOR Computational Methodologies & Operations Research
DEPARTMENT OF APPLIED INFORMATICS
aida artificial intelligence and data analytics

PLANNING AND SCHEDULING (2nd semester)

Assignment: 4th Assignment
Academic Year: 2024-2025
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Exercise 1: Truck Deliveries

In a transport company, there are several boxes that need to be delivered to their respective recipients. The company has a number of trucks, each with a different carrying capacity (payload) and a different speed. Each truck can transport one box at a time. It should be noted that the company has only 2 drivers. Each box that needs to be delivered is characterized by its weight, the time after which it is ready for delivery, and the total distance that the truck must travel to deliver the order. The data for your problem are given in the following tables:

```
ntrucks = 3;
```

the number of trucks

```
max_truck_weight = [15,20,30];
```

the maximum weight that each truck can carry - obviously a truck cannot carry a box that exceeds its maximum weight capacity.

```
speed = [ 10,20,5 ];
```

its speed. For example, truck 1 has a speed of 10.

```
ndeliveries = 5;
```

the number of boxes to be delivered,

```
weight = [ 5,10,18,22,10 ];
```

the weight of the boxes, e.g. box 1 has a weight of 5,

```
ready_after = [ 0 ,0,3,2,1];
```

the time after which it is available for delivery,

```
distance = [ 40 ,100,60,80,120];
```

the total distance of the delivery location (with the return of the truck). For example for the first box the distance is 40.

Write a program in MiniZinc that calculates (a) which truck will be assigned to deliver each box, (b) when the box delivery will begin, (c) how long it will take to deliver the box. You should calculate the program with the minimum total execution time (makespan). Example execution

```
departure = [ 0 , 0, 18, 2, 10];
delivery_time = [ 2 , 10, 3, 16, 12 ];
onTruck = [ 2 , 1, 2, 3, 1];
makespan = 22 ;
```

The above means that for the first box, the delivery will start at time 0 (departure), the delivery time will be 2 time points (delivery_time), and it will be delivered by truck 2 (onTruck). The total time is 22 moments (makespan).

The solution is NOT optimal. You will find the necessary files in eclass. You can use any solver you want.

Exercise 2 – Flight Control Center

In an air traffic control center, there are three daily shifts in total, morning, afternoon, night, and of course there is also the day off (off). There is a system of units (points) for calculating shifts. The morning shift counts one (1) unit, the afternoon two (2) units and the evening four (4) units. Every air traffic controller, when he completes 4 units (regardless of the sequence of shifts he will do) **must** take a day off. For example, the controller can do 4 morning shifts and then a day off, or 2 morning shifts and one afternoon shift, etc. The rules are:

- There should be at least 3 controllers on the morning shift, 2 controllers on the afternoon shift, and 1 on the evening shift.
- After any shift, the controller can take a day off. It is possible to have several days off in a row.
- Each controller should have at least one morning, one afternoon, and one evening shift in the seven-day schedule.

The schedule is prepared for the current week (7 days).

The problem data is:

```
enum CONTROL_SHIFT = {MORNING,AFTERNOON,NIGHT,OFF};
```

the enumerated type of shifts,

the number of controllers and the corresponding set

```
int : air_t_controllers ;
set of int: CONTROLLERS = 1..air_t_controllers;
```

the total number of days in the period,

```
set of int: DAYS = 1..7;
```

Each controller's work point is calculated as the sum of thepoints they collected from their shifts (1 point for morning, 2 for afternoon, 0 for off) for the time period.

The gap is defined as the difference between the points of the controller with the most points and the one with the fewest.

(a) Write a program in Minizinc that will find the shift schedule and display both the schedule, the gap, and the points collected by each controller. For example:

```
% Just for debugging. The table of shifts.
% 1 2 3 4 5 6 7
% MORNING MORNING MORNING OFF AFTERNOON OFF NIGHT
% MORNING MORNING MORNING OFF AFTERNOON OFF NIGHT
% MORNING MORNING MORNING OFF NIGHT OFF AFTERNOON
```

```
% OFF NIGHT OFF AFTERNOON MORNING MORNING OFF
% AFTERNOON OFF NIGHT OFF MORNING AFTERNOON MORNING
% AFTERNOON AFTERNOON OFF NIGHT OFF AFTERNOON MORNING
% NIGHT OFF AFTERNOON MORNING OFF MORNING MORNING
% NIGHT OFF AFTERNOON MORNING OFF MORNING AFTERNOON
% NIGHT OFF OFF AFTERNOON MORNING MORNING OFF
% OFF AFTERNOON MORNING MORNING OFF NIGHT OFF
% % Raw Data in Tables ------------
roster = [ MORNING, MORNING, MORNING, OFF, AFTERNOON, OFF, NIGHT, MORNING,
MORNING, MORNING, OFF, AFTERNOON, OFF, NIGHT, MORNING, MORNING, MORNING,
OFF, NIGHT, OFF, AFTERNOON, OFF, NIGHT, OFF, AFTERNOON, MORNING, MORNING,
OFF, AFTERNOON, OFF, NIGHT, OFF, MORNING, AFTERNOON, MORNING, AFTERNOON,
OFF, NIGHT, OFF, AFTERNOON, MORNING, NIGHT, OFF, AFTERNOON, MORNING, OFF,
MORNING, MORNING, NIGHT, OFF, AFTERNOON, MORNING, OFF, MORNING, AFTERNOON,
NIGHT, OFF, OFF, AFTERNOON, MORNING, MORNING, OFF, OFF, AFTERNOON,
MORNING, MORNING, OFF, NIGHT, OFF];
work = [ 9, 9, 9, 8, 10, 11, 9, 10, 8, 8 ];
gap=3;
```

In the above, the information that appears commented is to help you with debugging. and is the schedule of shifts/controller/day. roster is the table of shifts, where the shifts of the first controller are underlined, work array holds the points of each controller, e.g. the first controller has 9 points, and gap is the difference between the maximum points of a controller and the minimum.

(b) Change your code to calculate programs with gap = 1. You may need heuristics.

The code for (a) and (b) will be one. If you are unable to calculate (b) in a reasonable amount of time (<2min) you will submit code without the gap = 1 constraint. If you are able to do so, the code you submit will produce the program for gap = 1.

Notes

- The necessary files for the implementation of the two exercises can be found in ECLASS (Documents-> Constraints-> Assignments) **.**
  - Exercise 1: Trucks folder, project file truckDeliveryProject.mzp
  - Exercise 2: flightControlCenter folder, project file fc_shifts_project .mzp

SURRENDER

You will deliver within the date indicated in ECLASS ONE **zip FILE** with the following (**zip NOT 7z, rar, etc**):

- The above files **with the name and directory structure** they have in ECLASS **, which will contain your solutions.**
- **report.pdf** file (***in pdf format***), in the original zip folder, which will contain:
  - **On the first page, your Name, your Registration Number and your email.**
  - For each of the exercises:
    - code (regardless of whether **it** is in the report file) and comments about it.

- Examples of execution (1-2 where possible)
- Bugs and problems your code has.

ATTENTION : STRICTLY FOLLOW THE VARIABLE NAMES GIVEN ABOVE (AUTOMATIC CODE CHECK)

Good luck (*and have fun with MiniZinc!*)